Marine Physical Laboratory

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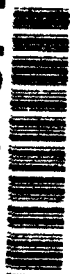
Upgrade of the LIMDAS Day/Night Whole Sky Imager
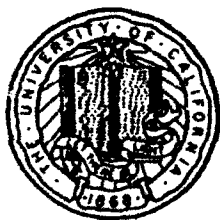
Kenneth M. Watson

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Kenneth M. Watson

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The Whole Sky Imager (WSI) is a ground-based system for assessment of cloud cover over the full upper hemisphere. Using a fish-eye lens and a slow scan CCD sensor, it acquires imagery through daylight, into moonlight and starlight conditions. At the start of this contract, the new Day/Night WSI was in brassboard configuration. This contract funding enabled MPL to complete assembly of the system and field it, and develop supporting software.

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Kenneth M. Watson

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Abstract

The Whole Sky Imager (WSI) is a ground-based system for assessment of cloud cover over the full upper hemisphere. Using a fish-eye lens and a slow scan CCD sensor, it acquires imagery through daylight, into moonlight and starlight conditions. At the start of this contract, the new Day/Night WSI was in brassboard configuration. This contract funding enabled MPL to complete assembly of the system and field it, and develop supporting software

Introduction

The Day/Night Whole Sky Imager (WSI) is a ground-based system for assessment of cloud cover over the full upper hemisphere. Using a fish-eye lens and a slow scan CCD sensor, it acquires imagery through daylight, into moonlight and starlight conditions. At the start of this contract, the new Day/Night WSI was in brassboard configuration. This contract funding enabled MPL to complete assembly of the system and field it, and develop supporting software.

The system has been delivered, and has been in use to support several Navy tests for missile tracking studies. The WSI has been very useful in these tests. It has provided information on the specific placement of clouds along the missile tracks, which can cause the tracker to break lock-on. Often these cloud structures are quite complex, and not visible by observers. In addition, the system has provided information related to the background flux levels against

which the tracker must work. The location of the moon aureole, for example, or background glow from nearby urban areas, along the missile track is important information to the tracking missions. Figure 1 shows a sample sky image with superimposed missile track. Note the clear sky (no clouds), with the urban flare from El Paso, 40 miles from the site. Figure 2 shows raw data, with a track superimposed, under conditions in which the cloud features provide the primary obstruction to the tracking mission.

Statement of Work

The Statement of Work for the contract is:

> a. Assemble, test, calibrate, and field, at the High Energy Laser Test Facility, White Sands Missile Range, NM, a night capable Whole Sky Imager, in brassboard semi-automatic configuration with preliminary documentation and operating instructions.

> b. Develop and make operational a code to extract cloud - thin cloud - no cloud information along a path in the sky described by the locus of points in azimuth and elevation representing an aircraft, missile or satellite track.

> c. Develop automated imagery acquisition algorithms for starlight night time cloud retrievals.

These contract requirements have all been completed. The WSI is on-site and operational. The code for extraction of the data along the track, including NITEDEMO and NITEVIEW, have been delivered, as has the code for automated data acquisition, RBGRABE. Several technical memoranda have been delivered, documenting these programs, the flux control algorithms required for automated acquisition, and the lunar algorithms for occultor control. In addition, the Day WSI, which was discussed in the text of the proposal, was repaired and the software upgraded during this interval.

Discussion

During most of this interval, the system has been operated using the program NITEDEMO. This program allows the user to acquire data at user-selected intervals, and with user-selected exposure and neutral density settings. The program automatically makes a dark image correction, and ratios the red/blue images to enhance the cloud features. Between image acquisition sets, the user may perform a variety of functions, including overlaying the track, plotting the data along the track, enhancing or false coloring the image, and overlaying angular information on the image. A related program, NITEVIEW, allows the user to perform these same functions with data which have been saved to disk.

The program RBGRABE is an automated program, which runs the WSI at pre-selected intervals, acquiring data throughout the 24-hour data day. This program uses a flux control algorithm, which was developed on the basis of data acquired with the program SAMPLE24. Program RBGRABE has also formed the basis for more a more sophisticated automated program, WSINITE, developed under separate funding.

The Day/Night WSI has operated quite well. The imagery is high quality, with excellent focus down to the horizon. The WSI is able to acquire outstanding imagery from the brightest daylight conditions down to starlight. Clouds are visually obvious in the raw imagery, and we feel these images will provide appropriate data for application of automated cloud decision algorithms.

The system was fabricated using an old computer from a Day-only WSI, and some of these old computer components required repair. Also, the occultor jammed in its track at one point and required a repair. We feel these problems have been quite minor for the first fielding of a newly developed type of instrument of this level of sophistication.

At this point in time, work has continued on the system via another contract (not through ONR), to enhance the automated acquisition code with user interrupts, and to enhance post-test presentation formats. A proposal to ONR is pending, which includes work on the cloud decision algorithms, as well as on other aspects of the WSI capabilities.

Conclusion

The Day/Night WSI fielded under this delivery order is the first of its kind in use. It has already been very productive in test support for the Navy. The system provides information regarding both the cloud features and the radiant background of the scene. The statement of work for this stage of the development has been successfully completed.

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